

august 1959

nlgi spokesman

Journal of the National Lubricating Grease Institute

Lubrication of Rolling Mill Gears and Bearings

By J. H. HITCHCOCK

Industrial Gear Problems from a Lubricants Manufacturer's Standpoint

By G. H. DAVIS

Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions



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Everyone concerned with the preparation or use of grease lubricants will find Boner's book of enormous practical value. Manufacturers and lubricating engineers will find here a complete breakdown of the effects of each ingredient of treatment upon the characteristics of the final product, and a full explanation of the physical and chemical methods used in measuring these characteristics. Suppliers of fats, oils, additives, thickeners and other raw materials will gain new ideas for future product research and development. In addition, users of grease products will learn the properties of available lubricants and the major purposes that each fulfills.

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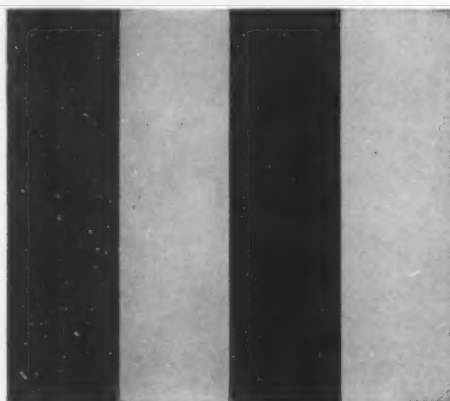
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NLGI PRESIDENT'S PAGE

By F. E. ROSENSTIEHL, *President*



Are Greases Safe in Foods?

It will probably come as a surprise to some lubricating grease manufacturers to learn that their products may come under the scrutiny of the U. S. Food & Drug Administration. Many may already have received inquiries regarding the effect on health of their greases in foods. This unusual situation exists because of the definition of a food additive in the Food Additives Amendment of 1958. In this law a food additive is "any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food . . ." unless such substance has been proven to be non-hazardous to the health of man or animal.

The law makes no distinction between materials added intentionally to a food and substances that accidentally or otherwise might get into food during processing operations. Greases would fall into this latter category of "accidental" food additives when used in machines or processes that permit their contact with the food.

How does this affect the grease manufacturer? No definite statements can be made now, but under the law the FDA must consider a food additive guilty of being a health hazard until proven otherwise. For this

reason many manufacturers and processors are inquiring about the safety of all materials, including greases that may get into their food products, either accidentally or otherwise. Some have already asked grease manufacturers if their grease has been "approved" by the FDA. Since the law covers packaging materials, similar requests may come to the grease manufacturers from their customers making food packaging materials.

The API has set up an Interdivisional Committee on Petroleum Food Additives to keep members advised of developments under the Food Additives Amendment, and to exchange information. This committee does not plan to conduct or support any research.

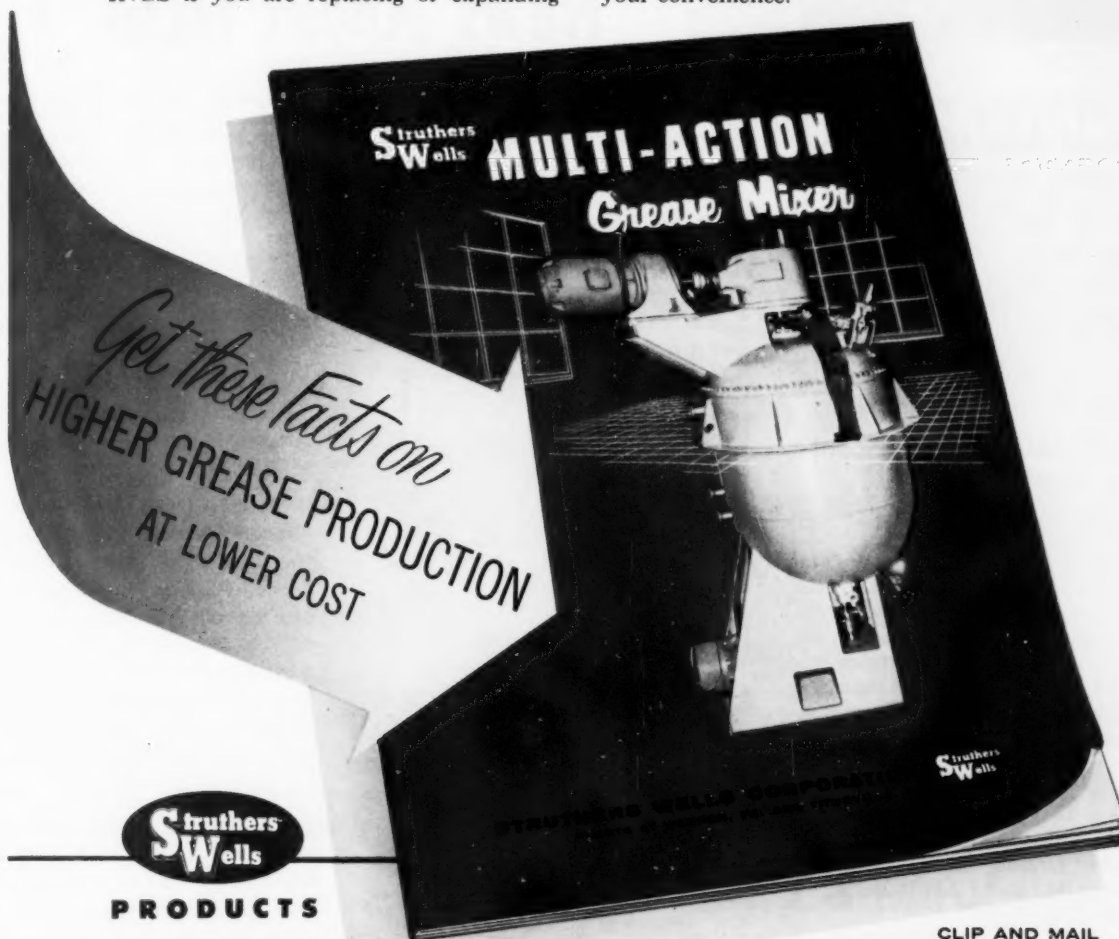
As of now there appears to be no likelihood of a blanket clearance for all greases, or even of a specific grease for all types of use in food processing. Each specific use will have to be considered separately. In some cases migration studies may yield adequate information to prove none of the greases or any of its ingredients can get into the food. Costly and long animal feeding studies may be necessary where there is positive proof grease is getting into the food. Each individual situation will have to be appraised separately and undoubtedly many questions will arise in the future in connection with this matter. ■

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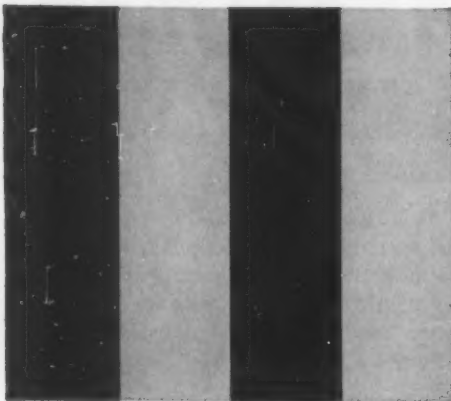
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News About NLGI

Bemol Joins NLGI

Bemol, Incorporated, manufacturers of lubricating greases in Boston, have joined the National Lubricating Grease Institute as an Active member. Company and Technical representative positions will be filled by Peter A. Magie. A feature article about this company will be presented in an early edition of the NLGI SPOKESMAN.

NLGI Requests Placement For Mailing Lists

Members and friends of NLGI have been invited to place the NLGI SPOKESMAN on their mailing lists for technical articles and bulletins, press releases and house publications . . . this compilation of information can be most useful in presenting the latest information to the lubricating grease and fluid gear lubricants industry.

NLGI Board Meeting

The board of directors of NLGI will convene for their regular September meeting on Monday, September 14, at the Hotel Roosevelt in New York City.

API Oil Drain Recommendation

Based on a recommendation by an advisory group of the American Petroleum Institute, in cooperation with automobile manufacturers, the following official API oil drain

recommendation (short form) was approved:

*"In winter, every 30 days;
In summer, every 60 days;
But never to exceed 2,000 miles"*

NLGI has not yet taken action on modifying its "Lubricate for Safety Every 1,000 Miles" slogan but it is expected that this subject will be considered at the next board meeting.

NLGI Introduces New Booklet

A new member service is being introduced to the industry with this issue of the journal . . . bound into the NLGI SPOKESMAN is a twelve-page booklet entitled "Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions." Like the famous Wheel Bearing manual before it, the Ball Joint booklet is an intra-industry effort and represents the cooperative efforts of many individuals and firms.

Printed in quantity to obtain a low price structure, the Ball Joint booklet is offered at cost plus handling and shipping. Quantity discounts and special imprint orders are shown elsewhere in this issue. All orders received will be assured same-day service, with shipment made from Kansas City by Express unless otherwise designated.

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of the most important lubrication services performed on automotive vehicles and with this approved version of proper methods now available, the Institute is again following the objective of disseminating technical data relative to methods of application.

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BONER'S BOOK—Manufacture

and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. \$18.50, prepaid.

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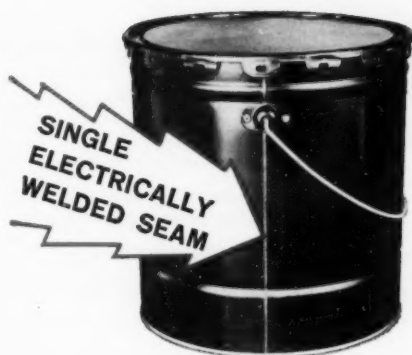
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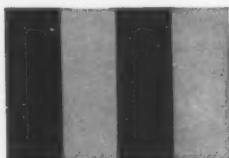


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Future Meetings

AUGUST, 1959

16-21 1959, National Congress of Petroleum Retailers Inc., 13th Annual Session, Jung Hotel, New Orleans, La.

SEPTEMBER, 1959

14 NLGI Board of Directors Meeting, Hotel Roosevelt, New York City.

16-17 Ohio Petroleum Marketers Association, Fall Conference and Golf Tournament, Sheraton-Cleveland Hotel and Lakewood Country Club, Cleveland, Ohio.

16-18 NPA Annual Meeting, Hotel Traymore, Atlantic City, N.J.

27-29 IOCA 12th Annual Meeting, Pick-Congress Hotel, Chicago, Ill.

OCTOBER, 1959

2-3 Association of Desk and Derrick Clubs of North America, 8th Annual Convention, Hilton Hotel, San Antonio, Tex.

11-15 ASTM Committee D-2 Meeting, Sheraton - Palace Hotel, San Francisco.

12-13 Petroleum Packaging Committee Meeting, Port Arthur, Texas

20-22 ASLE and ASME Joint Lubrication Conference, Sheraton-McAlpin Hotel, New York City.

26-28 NLGI Annual Meeting, Roosevelt Hotel, New Orleans, La.

28-30 Society of Automotive Engineers, National Fuels and Lubricants, La Salle Hotel, Chicago.

NOVEMBER, 1959

9-11 API, 39th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotels, Chicago.

10-12 API, Marketing Division, Congress Hotel, Chicago.

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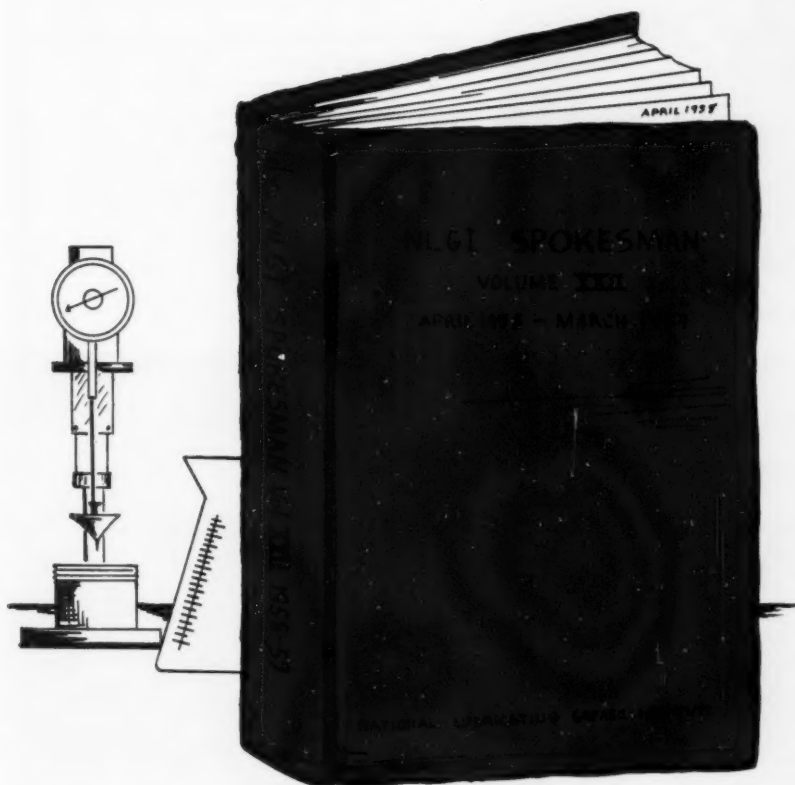
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Volume XXIII

August, 1959

Number 5

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THE COVER

THIS unusual pose is the final step in the illustrated booklet just offered by NLGI entitled "Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions," and as shown elsewhere in this issue, our cover expert is distributing the grease uniformly to bearing surfaces. A two-year project by many men of the Institute, NLGI's Ball Joint booklet is now being offered to the membership and the public as an approved method of application. For the complete booklet, along with price and delivery information, turn to pages 174 through 187 in this issue.

The NLGI SPOKESMAN is indexed by Industrial Arts Index and Chemical Abstracts. Microfilm copies are available through University Microfilm, Ann Arbor, Mich. The NLGI assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the NLGI. Copyright 1959. National Lubricating Grease Institute.

ANNUAL MEETING, 1959

Tentative Titles, NLGI 27th Annual Meeting Roosevelt Hotel, New Orleans, October 25-28

Sunday, October 25

"Mr. and Mrs. Early Bird Reception"

Monday, October 26 (morning session)

Address of Welcome

Keynote Speaker

Ten Years in Retrospect

The Ladies Are Invited...



Scenic New Orleans means a different type of Annual Meeting, with many wives attending, and sight-seeing on the agenda. The Institute will announce plans for ladies' entertainment and social activities at a later date, but all couples are cordially invited to attend the "Mr. and Mrs. Early Bird Reception" at the Roosevelt Hotel in New Orleans, Sunday evening, October 25.

Sponsored by more than twenty NLGI Associate member firms, "Early Birds" may meet old friends and gain new ones at the reception. This congenial get-acquainted affair will be the first formal part of the Annual Meeting . . . Sunday evening, 6 to 7:30 p.m.

Monday, October 26 (afternoon)

SPOTLIGHTING THE CHASSIS LUBRICANT MARKET

- a. Current Status of the Non-Lubricated, Non-Metallic Bearing in the Automotive Industry
- b. Procedures for Testing and Evaluating Chassis Lubricants

A Marketing Paper

ANNUAL BUSINESS MEETING

Tuesday, October 27 (morning session)

GENERAL

- Review of the Lubricating Grease Industry in Europe and Latin America
- A Modified Clay Thickener for Lubricating Fluids
- A Study of Open Gear Lubrication
- A Comprehensive Review of Lubricating Grease Containers
- Retention of Liquids in Soap/Hydrocarbon Systems

Tuesday, October 27 (afternoon)

SESSION A

SPOTLIGHTING MANUFACTURING PROCEDURES AND EQUIPMENT

1. Grease Mixer Design
2. A Philosophy of Grease Milling
3. Material Handling and Processing Aids in the Manufacturing of Grease
4. A New Technique for Measuring Grease Consistency in the Mixer.

SESSION B

SPOTLIGHTING OUR DISPENSING PROBLEMS

(Papers to be announced in succeeding issues of the NLGI SPOKESMAN)

ANNUAL SOCIAL HOUR

ANNUAL BANQUET

Wednesday, October 28 (morning session)

TECHNICAL COMMITTEE MEETING

Reports of Committees

Lubrication of Rolling Mill Gears and Bearings

Presented at the NLGI 26th annual meeting in Chicago, October 1958

By J. H. Hitchcock
Morgan Construction Co.

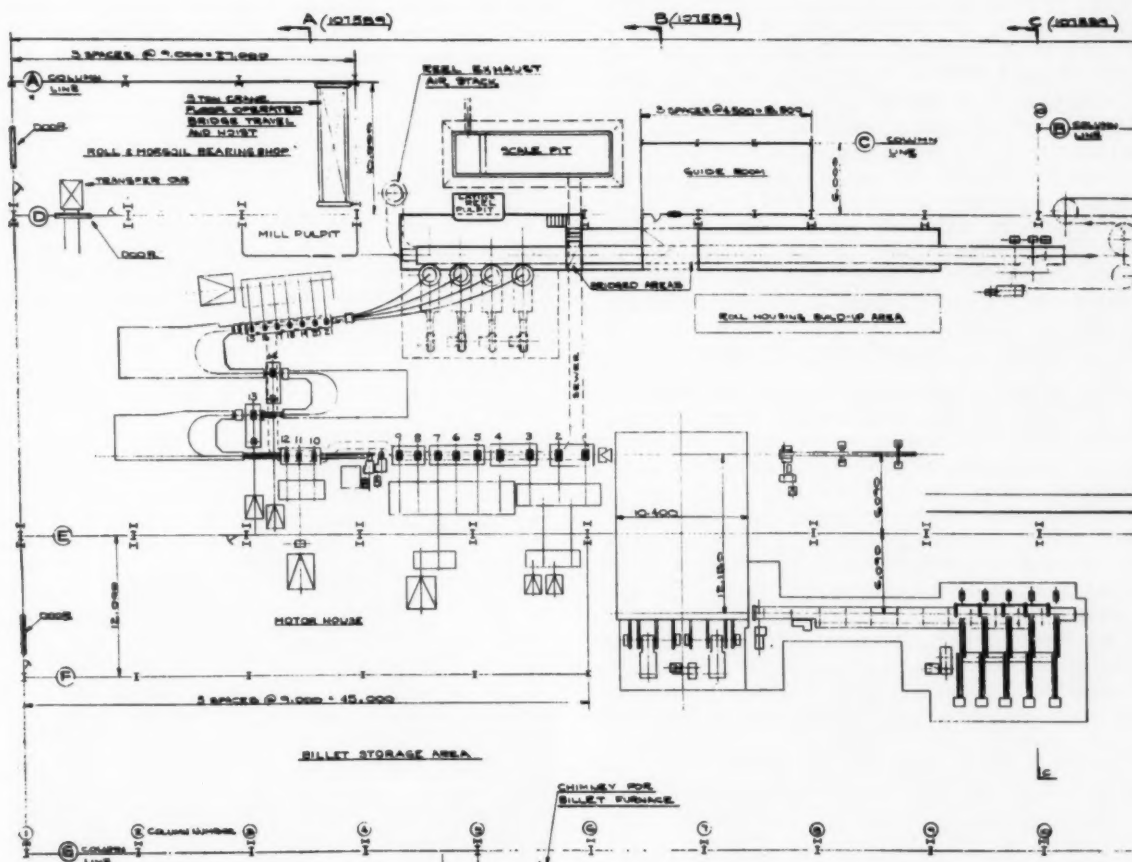


FIGURE 1

THIS ARTICLE DEFINES the lubrication requirements of the major components in the continuous rolling mills which we manufacture. These components include main drive gears, mill pinions, the bearings associated with the gears and pinions, and the oil film roll neck bearings.

Figure 1 illustrates diagrammatically the layout of a typical continuous rolling mill designed to produce wire rods. The solid black rectangles represent separate roll stands, of which there are twenty-one in this mill. Each roll stand contains two rolls which are mounted in four oil film roll neck bearings and driven through mill pinions. The drives of most of these stands also include reducing gears. Billets $2\frac{3}{8}$ inches square by 30 feet long, reheated from atmospheric temperatures in the furnace, are passed through the mill, becoming elongated and reduced in cross-sectional area as they pass through each pair of rolls. To compensate for the elongation that occurs in each pass, each pair of rolls must run faster than the preceding pair, the linear speed being inversely proportional to the cross-sectional area. The smallest product is wire rod approximately 0.20 inches diameter, which is approximately 180 times as long as the billet from which it came. This fact will explain in part the wide range of speed which is inherent in a mill of this kind. Products rolled on this mill include a variety of sizes, requiring variable speed relationships between successive stands, and for this reason, adjustable speed direct current motors must be used throughout. Speed adjustment is provided not only by field control, but in many positions additional speed range is available through adjustable voltage. In No. 1 stand, for example, a range from 8.5 to 25.6 rpm is available at full voltage, and a minimum speed of 6.4 rpm is available at reduced voltage. No. 21 stand operates at 1159 to 1975 rpm; here no reduced voltage is required.

The major components of this mill are lubricated by circulating systems which include receiving tanks, pumps, filters, temperature control equipment, alarm devices and signals, all designed to insure maximum continuity of operation. With the wide range of speed encompassed here, it is immediately obvious that use of a single lubricant throughout is neither desirable nor practical. It will be equally obvious that practical considerations preclude the selection of a different lubricant viscosity for each component. The solution to this situation, like most engineering decisions, is a compromise between the two extremes. The major components are grouped in accordance with operating conditions and geographical location, and a separate circulating system is designed to serve the components in each group, with a lubricant viscosity selected to suit the range of conditions encompassed within the group.

These considerations led, in this instance, to the specifications of five separate circulating systems; two serving the main gear drives and three serving the oil



FIGURE 2

film roll neck bearings. These bearings are necessarily located in a vulnerable position, exposed to cooling water and mill scale and although they are fully enclosed, the possibility of contamination is always present. In addition, these bearings must be put on and removed from the rolls at frequent intervals, with repeated possibility of damage to seals. By contrast, the gear drives are moderately remote from water and scale, and can remain fully enclosed for long periods of time. These and other reasons encourage separate lubrication of the roll neck bearings.

The first of the two systems allocated to the main gear drives serves stands Nos. one to nine inclusive. This group of drives includes two reducers of the type shown in Figure 2, each containing four oil film bearings and a single gear mesh. Also included is a more complicated drive, shown in Figure 3, which contains five points of gear engagement and fourteen oil film bearings. In addition, there are in this group seven drives of the type illustrated in Figure 4, each containing two points of gear engagement and six oil film bearings. Within this group of components, there are shaft speeds ranging from 6.4 to 750 rpm, pitch line

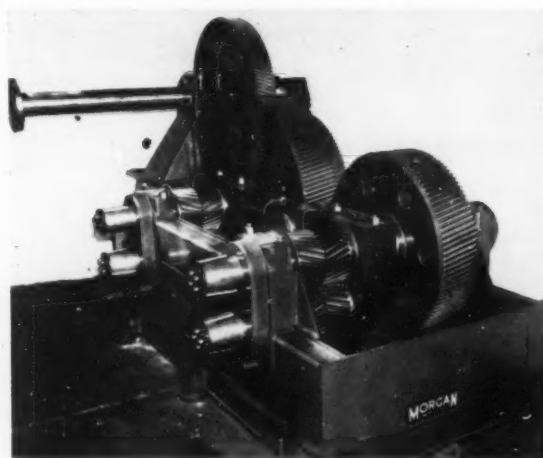


FIGURE 3

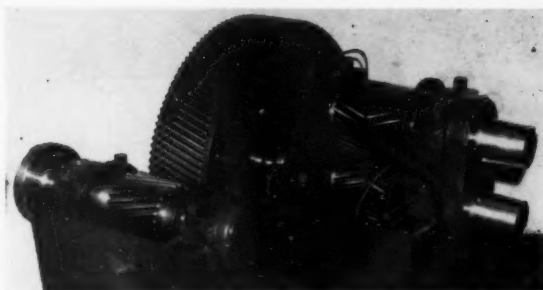


FIGURE 4

velocities in gear engagements ranging from 26 to 4860 feet per minute, and gear tooth loads ranging from 600 to 5100 pounds per inch of face width. Fortunately, the oil film bearings which support the gear and pinion shafts are subjected only to low unit loads. In fact, this is always the case when only gear tooth loads are involved, when shaft diameters are selected for a conservative value of stress, and when bearing length is made a reasonable proportion of diameter. Under these conditions, the unit load on bearings rarely exceeds 250 pounds per square inch.

Separate consideration of each element in this group might lead to viscosity selection ranging from 10 SSU for a bearing operating at 750 rpm, to 700 SSU for a bearing operating at 6.4 rpm, to 1500 SSU for a gear mesh operating at 26 fpm under a load of 5100 pounds per inch of face. The assembly of these elements into a group served by a common lubricant requires selection of a viscosity which will be suitable for all elements. Experience has shown unmistakably that higher viscosity than the minimum required is no detriment unless both speed and load are high enough to demand serious consideration of operating temperature. Consequently, selection of viscosity can always be based on the slowest most heavily loaded element. In this case the viscosity selected was 1400-1500 SSU. The only reason for limiting the specified range of viscosity to 100 SSU is the fact that this lubricant must serve a large number of elements operating under a wide range of conditions.

The analysts can assure us that the use of viscosity higher than the minimum, optimum value will lead inevitably to greater temperature rise and power loss. On theoretical grounds, I share this view fully. In installations of this kind, however, neither temperature rise nor power loss is large enough to be significant. Although measured data are meager, I believe it is correct to say that temperature rise in the lubricant supplied to gear drives never exceeds 30° and rarely exceeds 20°. Practical considerations outweigh the theoretical detriment.

A similar situation exists in the second lubricating system which serves the main drives in stands Nos. 10 to 21. Here shaft speeds range from 129 to 1975 rpm, pitch line velocities of gear engagement range

from 371 to 8520 fpm, and gear tooth loads range from 200 to 1500 pounds per inch of face width. Figure 5 illustrates one of the drives in this group, which serves the six-stand finishing train of the mill. This drive includes six pairs of spiral bevel gears, six pairs of mill pinions, and 31 oil film bearings, all contained in a common housing. As in the previous case, selection of lubricant viscosity for this system can be based on the slowest, most heavily loaded element. In this case, the viscosity selected was 700-800 SSU. And here again the specified range of viscosity is limited to 100 SSU, and lubricant temperature is controlled within narrow limits, not because the viscosity required for any single element is critical, but again because the same lubricant must serve a large number of elements operating under very different conditions.

The fact that a group of gear drives encompassing a moderately wide range of loads and speeds can be lubricated successfully with a single lubricant of selected viscosity demonstrates that selection of viscosity need not be a matter of critical importance for a single pair of gears within this range of operating conditions. Selection and control of viscosity become important in these gear drives only because of the range of conditions to which the single lubricant is applied. The lubricant specifications, apart from viscosity, call for a mild extreme-pressure additive of the lead naphthenate type. Lubricant is directed to the points of tooth engagement by nozzles, and calibrated orifices are provided in the supply lines to assure proper distribution of lubricant to all points of use.

Proceeding now to the oil film roll neck bearings, I refer again to Figure 1 showing the mill layout in diagrammatic form. These bearings are heavily loaded, commonly carrying 2000 to 3000 pounds per square inch, and the range of speed throughout the mill is 6.4 to 1975 rpm. Here again it is obviously impractical to use the same lubricant viscosity throughout. In fact, because of the greater temperature rise with speed and viscosity caused by the higher loads, control of viscos-



FIGURE 5

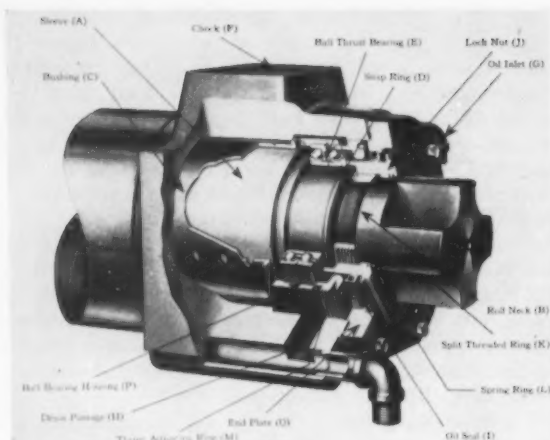


FIGURE 6

ity is decidedly more significant here than in the gear drives. For this reason, the roll neck bearings in this mill are separated into three groups rather than two, requiring three circulating systems. In addition, the first system serving the bearings in stands Nos. 1 to 7 provides independent control of viscosity for stands Nos. 1 to 4 through a cooler which reduces the temperature of lubricant supplied to these four stands. The viscosity selected for this system is 2400-2500 SSU at 100°F, and lubricant is supplied at this temperature and viscosity to the bearings in stands Nos. 5-7, but for the bearings in stands Nos. 1-4 the lubricant temperature is reduced to 85°F, increasing the viscosity to 4400-4500 SSU.

Stands Nos. 10-14 are served by a second circulating system, with lubricant viscosity selected at 1200-1300 SSU. The range of speed in this group is from 129 to 675 rpm. The third circulating system for bearings serves the finishing train, where the speeds range from 473 to 1975 rpm, and here the viscosity selected is 400-450 SSU.

Although the design features of these bearings have been described on numerous previous occasions, consideration of this subject may be assisted by a brief review. The cutaway view in Figure 6 illustrates the construction clearly. The bearing journal is a forged alloy steel sleeve which is mounted on and keyed to

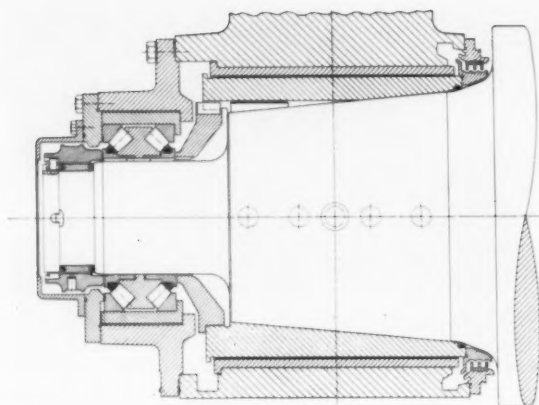


FIGURE 7

the tapered roll neck. The sleeve is surrounded by a stationary bushing, and a double acting ball thrust bearing is provided to carry end thrust in either direction. These vital parts are enclosed in a cast steel chock. Oil is introduced at a pressure of 12-15 lbs. per square inch, and is drained by gravity for return to the circulating system. The whole assembly is removed from the roll neck readily and integrally, after removal of the lock nut from the split threaded ring in the groove of the roll neck. Figure 7 illustrates in drawing form the cross section of a larger bearing, of the type used on backing rolls of four-high mills. Here end thrust is carried on a double row tapered roller bearing, instead of the ball thrust bearing employed in smaller sizes. Another distinction in this bearing is the oil flinger at the inboard end of the sleeve, which precludes escape of lubricating oil. This feature is especially applicable to dry cold rolling mills.

The successful lubrication of these bearings with a single lubricant viscosity throughout a moderately wide range of speed demonstrates clearly that there is wide latitude in viscosity selection for a particular bearing operating at intermediate levels of speed even at rated load. It is recognized, as stated earlier, that use of a higher viscosity than the permissible minimum leads to increase of power loss and temperature rise, and in general, this imposes no significant hardship.

About the Author

J. H. HITCHCOCK received his Bachelor of Science degree in mechanical engineering in 1925 from the Case Institute of Technology. He also did graduate study at the Carnegie Institute of Technology. From 1930 to 1933 he was research associate, ASME special research committee on heavy-duty antifriction bearings. From 1933 to 1946 he was employed as an engineer in the rolling mill department of the Morgan Construction Co. From 1946 to 1953 he was director

of research there and in 1953 became chief mechanical engineer. Professional societies include ASLE, SESA, AISE, ASM and ASME for whom he has served as chairman of the executive committee, Iron & Steel division, and chairman of the committee on plastic flow of metals. He also served on the research executive committee and was elected a Fellow in 1956. He was awarded for outstanding scientific achievement by the Worcester Engineering Society in 1956.



Industrial Gear Problems— From A Lubricants Manufacturer's Standpoint

By G. H. Davis
Shell Oil Co.

*Presented at the NLGI 26th annual
meeting in Chicago, October 1958*

The following article concludes a presentation of papers selected from a panel held at the 1958 NLGI Annual Meeting, at the Edgewater Beach Hotel in Chicago. Meeting concurrently and in cooperation with the American Gear Manufacturers Association, the session dealt with industrial gears and their lubrication. Other papers published in the NLGI SPOKESMAN from the panel include the preceding article in this issue by J. H. Hitchcock of Morgan Construction, entitled "Lubrication of Rolling Mill Gears and Bearings" and the papers offered in the April and May, 1959 issues. These papers are "Recent Developments and Trends in Industrial Gear Lubricants" by E. S. Reynolds of Socony Mobil (April), and "Gear Design and Means of Lubrication" by J. H. Allen of Farrel Birmingham (May). Extra copies of those issues may be purchased from the National Lubricating Grease Institute, through the national office.

JUST AS THE gear manufacturers have improved the quality of their products, so have the lubricants manufacturers tremendously upgraded their lubricants. This has been a process of evolution and has gone on as a cooperative venture. It is not the purpose of this paper to discuss recent developments in gear lubricants, as this feature will be very ably discussed by Mr. Reynolds.

However, I call to your attention some of the quality features being built into the modern industrial gear lubricant by the manufacturer.

1. Oxidation stability
2. Heat resistance
3. Anti-foam characteristics
4. Rust protection
5. High load-carrying capacity

These features have benefited all three parties interested in the best industrial gear lubrication—the gear manufacturer, the user and the lubricant manufacturer.

Some of the mutual problems that arise can be discussed under the following headings:

- A. Size of system
- B. Servicing
- C. Materials

D. Methods of applying
E. Overloads

A. Size of System

Under this classification, no criticism of the gear units themselves nor the bearings is intended. It does concern the capacity for the lubricant. We are all familiar with the generally accepted law of chemistry that, for every 10°C rise in temperature, the rate of oxidation doubles. Of course, this can lead to deterioration of the lubricant in spite of oxidation inhibitors. While this condition cannot be controlled 100 per cent by the volume of oil in the system, an ample reservoir will help tremendously, as this allows a longer rest period for the lubricant and usually produces lower temperature. For example, we encountered two gear sets from one manufacturer, one of 75 hp and one of 125 hp with identical 21-quart capacity reservoirs. In the smaller unit, the gear lubricant specified performed in a very satisfactory manner, but in the larger horsepower unit, oxidation caused a very rapid breakdown of the lubricant. As a remedy, it was recommended that the reservoir be enlarged. This was done by means of an auxiliary tank mounted in series and circulated by the same pump. Actually the size of the system was doubled by this procedure and the life of the lubricant raised by a factor of four.

B. Servicing

The AGMA have spelled out a very sane policy in their Standard 250.02. In too many cases, however, the instructions on flushing and periodic draining are not followed out. Aren't we all a little too "Scotch" to discard a lubricant that still looks good? Admittedly the change periods are based on averages, but isn't the cost of a new charge of lubricant insignificant in comparison to the cost of new gears or reconditioning an existing set. The subject of servicing should also include ambient conditions. If a gear case is installed in an unusually warm or humid atmosphere, these conditions must be taken into consideration in establishing a correct cleaning and draining schedule.

In some cases it has been found that certain gear units are not serviced due to inaccessibility and inconvenience; for example, on cranes or ore bridges where it is necessary to climb the equipment with tools, supplies and fresh lubricant.

Servicing could also cover improper locating of units. For example, it has been found that sometimes the breather pipe for the gear case is located near the floor without adequate protection to keep dust and dirt out of the lubricant. It is a simple matter to determine the nature and degree of contamination in the lubricant but so many times the gear manufacturer or the lubricant supplier gets a black eye because of conditions for which he is not responsible.

A last word on servicing—it is astounding what a small residue of kerosene in a gear case can do as far as degrading a fresh lubricant is concerned.

C. Materials

This is in no way meant as a criticism of the main components of a set of gears such as the gears themselves or the bearings. Certain other components perhaps deserve more study.

The well known catalytic effect of copper used in tubing and piping can be eliminated by using more inert metals for these parts.

If an oil cooler is employed, a positive pressure on the oil side will help eliminate water in the lubricant. If a heater is used, mounting the steam coils underneath the tank will help control water contamination.

Small items are sometimes overlooked. A case comes to mind in which the gear manufacturer used a Bunsen burner type of tip to spread the lubricant over the entire width of the gear mesh. The only problem was that the spreader was made out of common 70-30 brass and after a short usage, the lubricant naturally built up a slight acidic condition which extracted the zinc. This left the copper in a porous spongy condition which disintegrated. In turn, this finely divided copper actively promoted the oxidation of the lubricant. This whole chain of events could have been eliminated by using an aluminum or stainless steel spreader.

D. Methods of Applying Lubricants

There are still many, many of the old style open gear sets that are satisfactorily lubricated with residual or soap-filled lubricants that are applied hot by swabbing or pouring. However, most modern open gear sets are lubricated by spraying a greatly improved product on the teeth. These new sprayable lubricants are usually solvent cut-backs of very high viscosity base oils and contain active extreme pressure additives. As the solvent evaporates it leaves the gear teeth coated with a heavy, tacky adhesive film. Worthwhile savings due to reduction in loss of lubricant and also due to cleanliness of operation have been established.

Some of the problems that have arisen with this system have been due to misplacing of the spray nozzles and to not using enough spray equipment. It has been established that, if the spray is directed into the mesh or on the wrong side of the driven gear, windage and centrifugal forces can tend to throw the lubricant off the gear. Also, if not as many nozzles are used as needed, poor coverage will result in turn causing rapid wear. A typical application was at a cement plant, where a ball mill was installed with three nozzles to cover the gears with a width of 28 inches. The nozzles were mounted only three inches from the gear teeth, and as a result, the cone of lubricant was not sufficient to lubricate the entire face of the gear and the lubricant was blamed for allowing rapid wear to take place. By using four nozzles and mounting them six inches from the gear, adequate coverage was accomplished and the rapid wear eliminated.

Problems encountered in methods of applying the

lubricant can also include those arising from modification or rebuilding of existing equipment by the user. One particular case comes to mind in which a steel mill rebuilt a 26-inch three-hi billet mill. The pinion stand had been lubricated with a residual open gear product and it was decided to put this on a circulating system. Because of the location and the lack of head room the return line did not have enough slope to handle the proper grade of lubricant in spite of using a larger pipe than was necessary. It was, therefore, imperative to use a much lighter viscosity material and the deficiency in body was compensated for by using a much more powerful E.P. additive. This has worked satisfactorily for over 10 years.

E. Overloads

The gear manufacturers have always done a very thorough and complete job in engineering their units for certain specified loads, speeds and operating conditions, but how many times have we seen these elements stressed beyond mechanical endurance after the equipment has been in use for some time. The desire to increase production with presently existing machinery is often overpowering. When this condition exists, the lubricant is often unfairly criticized. One particular instance was forcibly brought to our attention in which a manufacturer of a very competitive product was driving a particular machine with a 45 hp motor through a worm gear drive. To increase production, the machine was speeded up and the motor changed to 90 hp unit. This seemed to work quite satisfactorily. However, the next step was to increase the speed further and a 200 hp motor was installed. The amount of work being put through this gear set was just too much both for the gears and the lubricant. The consumer was made to understand the facts of life in this case but claimed the increased production more than compensated for the increased maintenance. Due to the design, it was impossible to increase the size of the worm gear drive, but the use of a lubricant that had better resistance to thinning out under heat helped to some degree.

While this may be an extreme, we will all agree that overloading, whether by increased throughput or by misalignment is an ever present problem. Maybe some of this is self-induced as today's gears are such

excellent machine elements and the modern lubricants are so vastly improved over those offered in the past.

An entirely different type of problem has arisen that cannot be attributed to any one gear manufacturer or user. This is due to a machine designer or builder incorporating two or more separate and distinct types of gear units in a common system. For example, we have found spur gears and a worm gear in the same power transmission system on one machine where only one lubricant could be used. In this instance, a highly heat and oxidation stable leaded gear lubricant was recommended. The manufacturer of the worm gear unit was highly critical of this recommendation based on some bad experience with unsatisfactory leaded oils; however, we felt that our recommendation was justified by the loading on the gears and the quality of the mild E.P. lubricant. In the past some of the leaded oils, particularly the lead oleate blends, had caused troubles due to instability but many successful applications have been made on this type of equipment. It is only necessary to review the large number of screw-downs in the steel industry that have been lubricated with leaded lubricants for many years. Further, it is a well known fact that one of the largest industrial concerns has satisfactorily lubricated all their gears of all types and kinds with E.P. lubricants. In addition, a survey by one lubricant supplier showed that many different grades, viscosities and qualities, were actually being used in various makes of worm gears. This condition had, like Topsey, "Just grewed." This problem is insoluble unless there is give and take on both sides—the gear manufacturer and the lubricant supplier.

In closing—a word of appreciation to the American Gear Manufacturers Association. The literature they have published has been of great assistance not only in recommending the proper grade and type of lubricant, but also in handling complaints. They have dramatically spelled out the various causes of failures and not attempted to evade the question by blaming the lubricants when they were not at fault. Continued cooperation between the two groups will lead to a better understanding of our mutual problems, and I am sure from the standpoint of a lubricant supplier, lead to improved and higher quality lubricants.

About the Author

G. H. DAVIS attended the Case School of Applied Science and graduated from the Case Institute of Technology in 1924 with a degree in mechanical engineering. He worked for Sinclair Refining company from 1924 to 1929. Since 1929 he has been with Shell Oil Company holding many locations

and assignments, all in industrial lubrication. His present assignment is staff engineer, industrial products, handling marketing problems as they apply to heavy industry with particular emphasis on gear lubricants. Mr. Davis is a member of ASLE and the Association of Iron and Steel Engineers.



A New Member Service is Offered The Lubricating Grease Industry . . .

Two years in the preparation . . . scores of experts participating . . . a number of contacts outside the industry . . . these are just some of the ingredients which went into NLGI's latest booklet, "Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions," which is shown for the first time on the opposite page. Like its companion piece introduced in 1954, the Wheel Bearing manual, this new Ball Joint booklet is bound into the NLGI SPOKESMAN in order that the industry may have an opportunity to examine this approved method for applying lubricating grease.

In the thorough processing that accompanies a work of this nature, a great number of experts assist in the constant check and recheck which continues throughout the life of the project. Many of these men and women are anonymous but are recipients of the Institute's gratitude . . . they have given exceptionally of themselves and their knowledge. Listed below are only those designated as committee members—they include:

- F. R. Hart*, Standard Oil Co. (California), Chairman, 1958.
- W. M. Murray*, Kerr-McGee Oil Industries, Chairman, 1959.
- T. G. Roehner*, Socony Mobil Oil Co., Chairman, NLGI Technical Committee.
- P. V. Toffoli*, Pure Oil Co., Chairman, Technical Sub-Committee.
- S. C. M. Ambler*, British American Oil Co.
- D. P. Clark*, Gulf Oil Co.
- J. W. Lane*, Socony Mobil Oil Co.
- G. Landis*, Atlantic Refining Co.
- W. A. Magie, II*, Magie Brothers Refining Co.
- G. E. Merkle*, Fiske Brothers Refining Co.
- J. Panzer*, Esso Research & Engineering Co.
- T. F. Shaffer*, Shell Oil Co.
- J. V. Starr*, Esso Standard Oil Co.
- J. B. Stucker*, Pure Oil Co.

Also active in guiding the work along through its many stages were the chief executives of NLGI . . . R. Cubicciotti of L. Sonneborn Sons in 1958, and F. E. Rosenstiehl of Texaco, in 1959.

After working up an approved method, the following step is to have the booklet distributed throughout

Continued on page 187

INTRODUCE NEW NLGI SERVICE MANUAL ON BALL JOINT LUBRICATION

Recommended Practices
for Lubricating
Passenger Car
Ball Joint
Front Suspensions

published by

**NATIONAL LUBRICATING
GREASE INSTITUTE**





ESTABLISHED 1933

The National Lubricating Grease Institute is a technical and marketing association for the lubricating and fluid gear lubricants industry. Its objectives include developments of better lubricating greases and gear lubricants for the consumer, and better lubrication engineering service to industry. A monthly journal, the NLGI SPOKESMAN, is recognized as the leading magazine serving consumers of lubricating grease and the lubricants industry, in this country and abroad.

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FOREWORD

Proper lubrication of ball joint suspensions on passenger cars is one of the most important lubrication services performed on automotive vehicles. Based on the success and world wide acceptance of the preceding booklet "Recommended Practices for Lubricating Automotive Front Wheel Bearings," it was the decision of the NLGI Board of Directors to supplement the Wheel Bearing Manual with a similar booklet on ball joint lubrication. First, through members of NLGI's Technical Committee and then coordinated by a special Marketing group, the ball joint booklet has evolved over a two-year period, the product of many men who gave of their time and experience, their object . . . to establish a series of procedures which would insure complete and satisfactory ball joint lubrication.

Because literally scores of experts assisted, shown below are only those designated as committee members. They include:

F. R. Hart, Standard Oil Co. (California) Chairman, 1958
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Acknowledgement also is made of the efforts of NLGI's presidents . . . R. Cubicciotti of L. Sonneborn Sons in 1958 and F. E. Rosenstiehl, Texaco, Inc., in 1959.

August, 1959

NATIONAL LUBRICATING GREASE INSTITUTE
4638 J. C. Nichols Parkway, Kansas City 12, Missouri

Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions

BALL JOINT SUSPENSIONS AND THEIR LUBRICATION

The ball joint suspension combines both front suspension action and steering action at two ball joints. Ball joints allow the up-and-down movement of front wheels due to road irregularities and the pivoting movement which takes place as the wheels are turned while steering. They provide a spherical bearing surface to withstand the thrust and turning loads. Because of the loads which are transmitted to the ball joints, the bearing surfaces must have good wearing qualities and should not be critical to lubrication. The bearing surfaces are usually grooved to permit uniform distribution of grease over the entire bearing surface.

Ball joints *must be lubricated at least once every 1000 miles* with a generous amount of a suitable lubricating grease to permit two-directional action at each ball joint and to prevent noise. Lack of lubricant will result in the entry of water and dirt into bearing area and premature wear. Care must be taken when lubricating ball joints because the load on them makes it difficult for the lubricant to reach all bearing surfaces.

A grease fitting is provided in the side or end of each ball socket through which grease is pumped to the joint. Most of the grease fittings are the short threaded type to eliminate the possibility of the thread extending far enough into the socket to interfere with the free movement of the joint. Caution: If it is necessary to change the grease fitting, be certain a short threaded type is used.

A seal is used at each ball joint to retain grease and to exclude moisture and dirt from the bearing surfaces. This may be a rubber seal or a combination metal deflector and rubber.

Noisy ball joints can result if the lubricant does not reach all the bearing surfaces or if the joints are not lubricated often enough to maintain lubricant on all bearing surfaces. Two types of front-end noises are a warning that lubrication is required. One type of noise is noticed with a slight movement of the suspension as when pushing downward firmly but slowly on the front fender. Its intensity ranges from a tap, thud or crunching noise to a very loud squeak. This noise is usually from the lower ball joint. The other noise is a snapping noise, heard when bouncing the front suspension through large movements and is usually in the upper ball joint. Both noises can be corrected, or controlled by a careful lubrication job.

APPLICATION OF LUBRICANT

OPERATION 1—Raise the car in such a manner that the weight of the car is on both lower control arms as close to the wheels as possible. On some lifts it may be necessary to lay a plank across the side rails or use special adapters or floor jacks.

NOTE: Leave sufficient room for the grease gun to reach the lower fittings. When the car is raised in this manner, the lower ball joint is unloaded and the upper control arm rubber bumper will be away from its stop. Preloaded ball joints cannot be unloaded.



Operation 1.

OPERATION 2—Wipe road dirt from each lubrication fitting.



Operation 2.



Operation 3.

OPERATION 3—A generous amount of suitable lubricating grease should be applied to the fitting in the lower ball joint to completely flush old lubricant from the joint.

Grease should flow out all around the seal.

Pressure should be applied to the grease gun intermittently to cause an up-and-down motion in the ball joint to assist in the thorough lubrication of all moving parts. This will be noted as an up-and-down movement of the wheel assembly. Such movement indicates that the ball joint is unloaded and does not indicate worn parts.

If lubricant cannot be forced into the ball joint, it may be due to an obstruction or a mechanical maladjustment in the bearing area. In this case, the customer should be referred to a qualified repair shop. Excessive pressure can force the lubricant fitting out of its housing with thread stripping.



Operation 4.

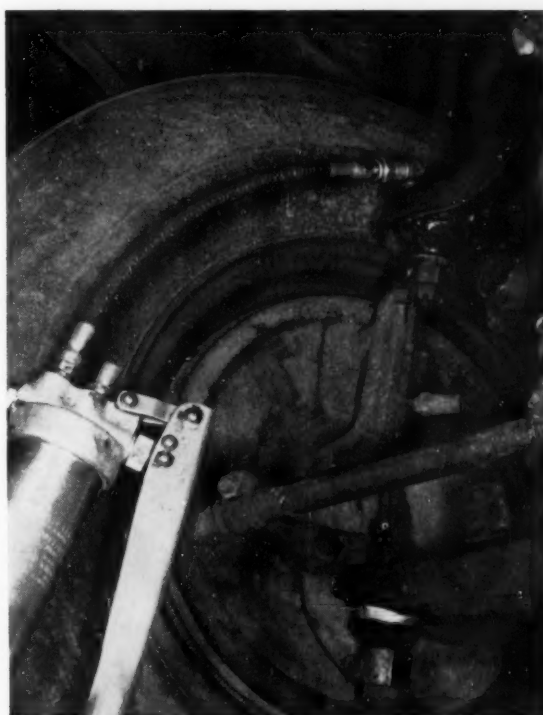
OPERATION 4—Following lubricant application, wipe excess lubricating grease from the fitting.

OPERATION 5—Next, turn the front wheels from side to side to allow the lubricant in the joint to flow to all bearing surfaces.



Operation 5.

OPERATION 6—Apply a generous amount of a suitable lubricating grease intermittently to the upper joint to flush out all old lubricant. Lubricant will only come out on one side of the seal because the upper ball joint is preloaded.



Operation 6.



OPERATION 7—Wipe off excess grease.

Operation 7.



OPERATION 8—Turn the wheels from side to side several times while applying lubricant so that it will be distributed to all parts of the joints.

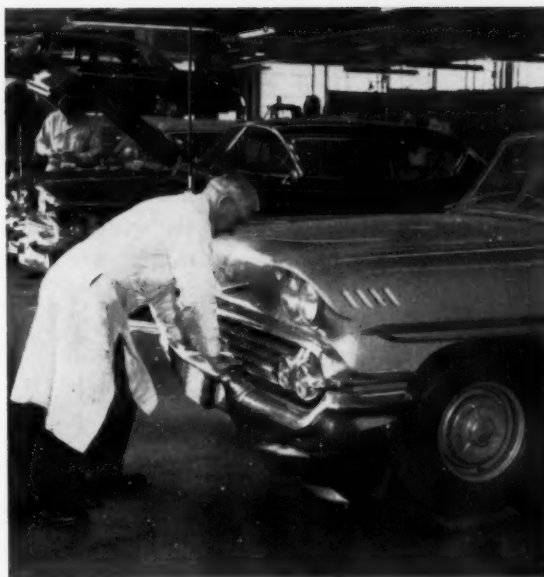
Operation 8.

OPERATION 9—Lower the car to the floor. Bounce and rock the car from side to side several times. This will help distribute grease uniformly to the bearing surfaces. It may be necessary to repeat the bouncing procedure. If noise persists, relubricate.

Operations 4 and 7 are repeated instructions.

Operations 5 and 8 are similar to each other; removal of excessive grease and distribution of lubricant by wheel manipulation are essential from cleanliness and lubrication viewpoints.

IMPORTANT—Dealer personnel obtain authorization from customer before replacing defective parts.



Operation 9.

BALL JOINT CONSTRUCTION AND MECHANICAL REPAIR

The ball joint suspensions connect the upper and lower control arms to the steering knuckle, eliminating the king pin. They consist of a pair of ball and socket bearings.

The ball sockets are attached to the outer ends of the upper and lower control arms by various means—some are riveted, some bolted and others are threaded into the control arms. Tapered shanks of the ball studs fit tapered holes in the spindle supports and are held in place with castellated nuts and cotter pins. The studs are below the ball in all upper control arms; but in lower control arms, the stud may be above or below the ball.

Upper and lower ball joints are not interchangeable. The upper joint is preloaded while most lower joints are not. Upper ball joints may be preloaded in a number of ways. Two methods currently in use are: Compression of a coil spring between the cover plate and the ball seat. Compression of a rubber disc between the cover plate and the ball seat. Some lower joint designs use a loose ring of balls to carry the load and to provide freer steering motion.

In severe cases of noise, it may be necessary to rotate the ball studs, changing their position in the bearings, to eliminate noise. However, this should not be attempted unless the work is done by a qualified mechanic who has approved shop manuals and equipment and the required specifications for tightening the stud nuts.

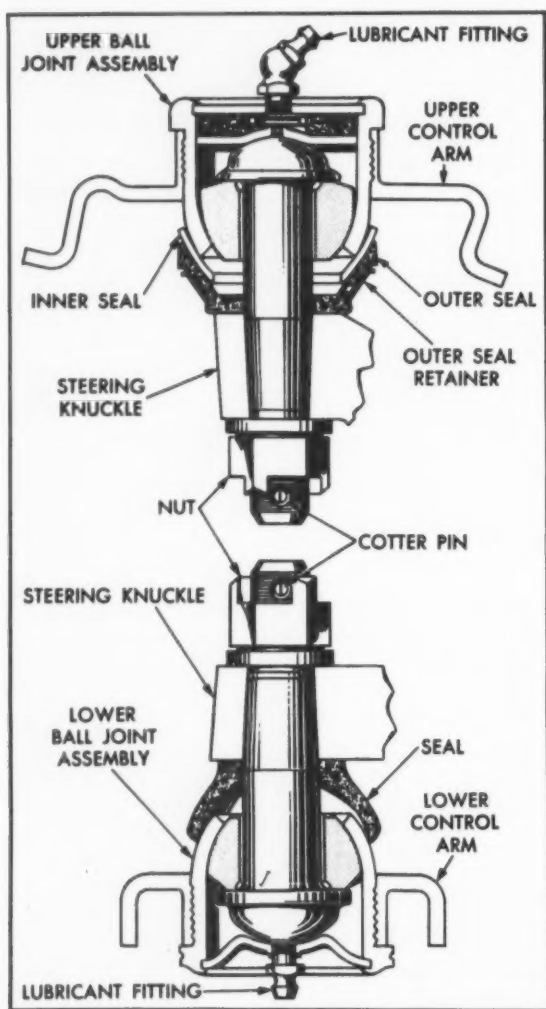


Figure 1.

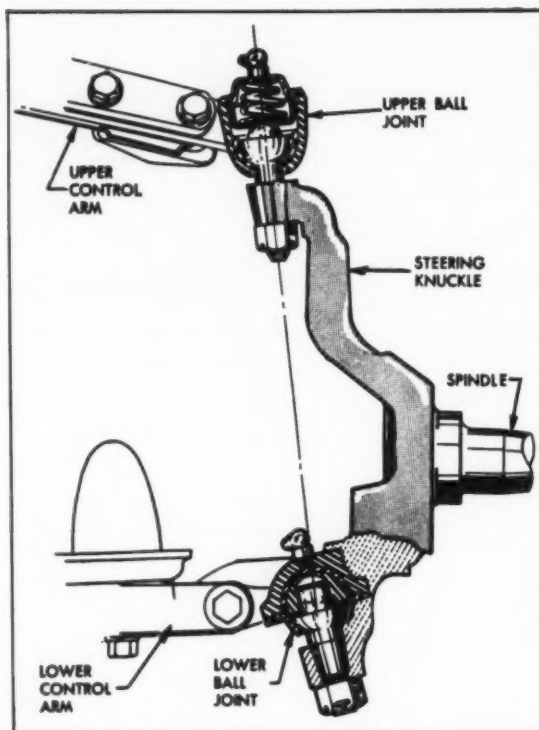


Figure 2.

When extensive repairs are made, it may be necessary to realign the front wheels. If the service station is not adequately equipped, the attendant should refer the car owner to a qualified repair garage.

To rotate the ball studs, mark the ends of the upper and lower studs to show their initial position in the steering knuckle bosses. Loosen the stud nuts. This loosens the stud tapers in their seats. Rotate the studs 90 degrees and retighten the stud nuts with a torque wrench to their specified torque. Insert the cotter pins. Lubricate the ball joints as already described.



ESTABLISHED 1933

National Offices:
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Kansas City 12, Missouri
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BALL JOINT—continued

Some NLGI'ers Who Participated in the Preparation of the New Booklet



Ambler



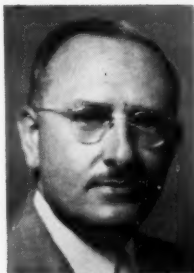
Clark



Hart



Landis



Lane



Magie



Merkle



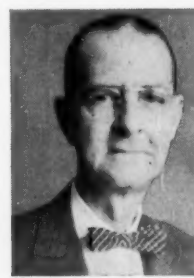
Murray



Panzer



Roehner



Starr



Toffoli

the industry. Designed for use in the service station and garage, the Ball Joint booklet has been printed in one large order so that cost-per-copy is quite low. All charges for the booklet are based on the printer's charge, plus handling and shipping. Again, like the Wheel Bearing manual before it, the Ball Joint booklet can expect to see world-wide distribution (more than 150,000 Wheel Bearing manuals have been sold), and its employment will come from almost every organization interested in propounding a correct application procedure.

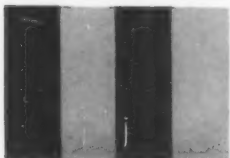
Members and friends of NLGI may purchase any number of Ball Joint booklets from the national office in Kansas City, with or without special company imprints, as shown on the price schedule (*below*). Orders will be processed on a same-day basis, with shipping charges based on costs from Kansas City.

Price List

"RECOMMENDED PRACTICES FOR LUBRICATING PASSENGER CAR BALL JOINT FRONT SUSPENSIONS"

(1) Number of Copies	(2) Plain, Without Company Imprint	(3) *Company Name Imprinted in Black	(4) *Company Name Imprinted in Red
1-24	20c each
25-49	17c each
50-99	15c each
100-499	\$14 per 100	\$14 per 100	\$15 per 100
500-999	\$13 per 100	\$13 per 100	\$14 per 100
1,000-10,000	\$120 per M.	\$120 per M.	\$130 per M.
10,000-15,000	\$110 per M.	\$110 per M.	\$120 per M.

*To the prices in column (3) please add a flat charge of \$18.00 and to the charges in column (4) a flat charge of \$25.00 . . . both charges are for type changes.



Chek-Chart Corporation Joins NLGI

Lubrication Publications Are Famed for Accuracy and Up-to-Date History

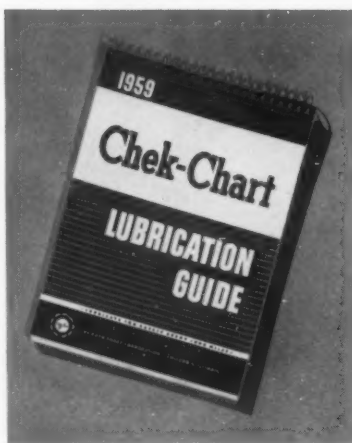
For more than thirty years—ever since the beginning of specialized automotive lubrication, the Chek-Chart Corporation has served the oil and automotive industries as a clearing house for up-to-date and authentic lubrication data.

The corporation was organized by the late Raymond Shaw in 1929 to answer a need for practical, usable information on how to properly lubricate the rapidly increasing number of cars on the road.

Its efforts were highly instrumental in the standardization of automotive lubricants. In 1933 the number of lubricants recommended by the car manufacturers was listed at 101 types and grades to service the car models then in use; today, relatively few different products do the entire job—and do it well.

During World War II, the U. S. War Department called upon Chek-Chart to develop a lubrication program for the maintenance of the largest mechanized force the world has ever seen. Chek-Chart was also called upon to render similar service to the Canadian Ordnance Corps.

Chek-Chart has developed automotive lubrication charts to the point where these charts are recognized as the standards of factory-approved automotive lubrication. The use of the charts, which indicate every point of lubrication serv-



FAMED lub guide—1959 edition

ice, assures both the stationman and the car owner that the car has received lubrication in accordance with the recommendations of the car manufacturer.

Over the years, Chek-Chart has developed many other popular services: truck lubrication guides and truck preventive maintenance programs designed specifically for truck fleet operators; farm tractor guide programs for the proper care of the nation's farming equipment; wall charts and recommendation booklets showing capacity information along with motor oil and gear lubricant recommendations.

Chek-Chart's Chexall accessory

service publications cover the field of tire, battery and accessory items for the entire automotive industry.

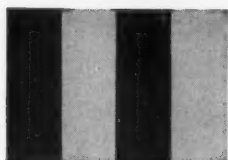
A complete line of training aids in the form of the How and Why series of manuals have been widely accepted as standards for keeping stationmen informed of the latest techniques in automotive lubrication and in the merchandising and installation of TBA items.

As part of its service Chek-Chart publishes a monthly service bulletin, widely read and reprinted by its clients.

Chek-Chart maintains an engineering office in the General Motors building in Detroit as a means of keeping in close personal touch with car manufacturers at all times. It also has a Canadian subsidiary, Chek-Chart Corporation, Limited, which serves the Canadian oil industry with basically the same products as published in this country.

The publications are used by oil marketers throughout the United States and Canada and in practically every free country in the world. They have been translated into twelve foreign languages and have been accepted as the standard for automotive lubrication and accessory service information.

Since the death of the founder, Ray Shaw, in 1957, Hunt Eldridge, long connected with the field of lubrication, has been president.



Literature and Patent Abstracts

Application

Don't Mix Wheel Bearing Lubes

The April 1959, *Chek-Chart Service Bulletin* has a full page dealing with the above subject. While either a sodium or a lithium soap base lubricant is satisfactory for wheel bearing application, the user is cautioned that the two types may not be compatible and hence should not be mixed. For this reason, new lubricant should never be added to the lubricating grease already in the bearing.

Proper cleaning and drying of the bearings is described after which the use of a wheel bearing packer is recommended. Finally it is emphasized that repacking wheel bearings is an important and critical automotive service worth catering to.

Process

Process for Preparation of Lubricating Greases with Clay Thickeners

British patent 794,711, described in the December 1958 *SPOKESMAN* describes a process which is now also covered by U. S. Patent 2,875,152, whose author is Van Scoy,

and which is assigned to Shell Development Co.

Referring to Figure 1 it will be noted that the process, starting with raw clay, involves some seven steps to form a finished lubricating grease. The description is particularly concerned with removal of the water used in the first few steps which is accomplished by first forming clay-oil curds which can be passed over rotating, inclined screens and next by passing the mass over heated surfaces in a thin film and for a short residence time.

Gear Lubricants

Investigation of Factors Affecting High-Temperature Gear Operation

By E. E. Shipley, *Lubrication Engineering* 15, pp. 98-103, 119, 1959

A full scale high temperature gear testing facility, permitting a maximum pinion speed of 24,000 rpm and a maximum test box temperature of 700°F. permits evaluation of proposed lubricating fluids.

About 25 different fluids were tested as to oxidation resistance at 500°F. and it was concluded that the silicone group and the chlor-

inated biphenyls were outstanding when compared with MIL-L-7808C diester. The latter material shows less wear than do the silicones.

Composition

Terephthalate-Thickened Lubricating Greases

According to Hotten (U. S. Patent 2,874,121, assigned to California Research Corp.) lubricating greases, which will lubricate effectively at temperatures in excess of 300°F., consist of lubricating oils thickened with a metal salt of a monoester of terephthalic acid. The particular

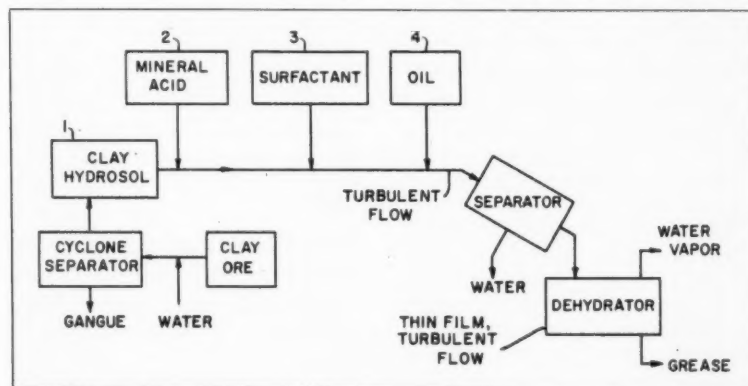


FIGURE 1

AUGUST, 1959

HARSHAW LEAD BASE

Harshaw Lead Base, as an additive to petroleum lubricants, improves extreme pressure characteristics and imparts the following desirable properties:

- Increased film strength
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- Improved wetting of metal surfaces
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Harshaw Lead Bases are offered in three concentrations to suit your particular needs:

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(For Graco Suppliers, see SPRAYING or LUBRICATING DEVICES in Phone Book Yellow Pages)

claims for such compositions are that they are resistant to oxidation and emulsification in water and that they exhibit low wear at high temperatures.

The thickening agents are prepared by reacting a diester of terephthalic acid with an amount of a basic substance sufficient to saponify one of the ester groups, using a solvent in which the metal salt of terephthalic acid is insoluble. A variety of esters which have similar or dissimilar ester groups may be used but apparently the remaining ester group influences both the dropping point and the consistency of the finished lubricant.

Claims are made for the use of either alkali or alkaline earth metals as a component of the thickener. One example of a barium base product had a melting point of 220°F., whereas several illustrations of sodium base lubricants had dropping points varying from 322 to 500+°F.

A typical lubricating grease was prepared by reacting sodium hydroxide with dimethyl terephthalate in benzene to form a sodium monomethyl terephthalate gel. This gel was mixed with a California solvent-refined paraffin base oil having a viscosity of 450 SUS at 100°F. The benzene and methyl alcohol were evaporated, leaving a smooth lubricating grease containing 15 percent by weight of the thickener. This product had a dropping point of 500+°F. and a work-penetration of about 300.

Increasing the Stability of Sodium Base Lubricating Greases

When 0.1 to 5 percent of certain stabilizing agents are added to sodium base lubricating greases the oxidation and shear stability are improved. These additives, described by Metenier and Signouret (U. S. Patent 2,874,122, assigned to Esso Standard Societe Anonyme Francaise), consist of reaction products of phenolic-amino-resins with an alkylene oxide. Typical stabilizing agents C and D were prepared as follows:

	C	D
Octyl phenol	100	100
Dilution oil (29-38 cs. @ 50°C)	110	50
Trioxymethylene	20	20

These mixtures heated for six hours at 130 to 150°F. after which 15 parts of ammonia were injected during six hours, then heated for two hours at 212 to 220°F. and finally for three hours at 300°F. These resins contained 1.4 and 2.2 percent nitrogen. Next the first resin was reacted with 15 percent of ethylene oxide at a temperature of 320 to 356°F. for fifteen hours and the second resin was reacted with 25 percent of ethylene oxide for 20 hours at 320°F.

A lubricating grease was prepared from 15 percent of stearic acid, 2.45 percent of sodium hydroxide and 82.55 percent of a lubricating oil having a viscosity of 32 sc. at 100°F. and a V.I. of 115. The mixture was heated to 390°F., pan cooled and homogenized when cool to give a lubricant of 350 worked penetration which showed a five pound loss in an oxygen bomb in ten hours. Also, this product was fluid after 100,000 strokes in a grease worker.

After the addition of 1 percent of additive C a worked penetration of 287 was obtained which increased to 345 after 100,000 strokes. An oxygen pressure drop of five pounds occurred after 400 hours. By adding 1.5 percent of additive D to the base grease a product having a worked penetration of 283 and a 100,000 penetration of 325 was obtained which exhibited a five pound pressure drop in an oxygen bomb in 600 hours. Oil separation was also lower with the latter two mixtures than with the base lubricant.

Stabilized Calcium Fatty Acid Base Lubricating Grease

According to Dilworth, Uhrig and Becker (U. S. Patent 2,877,181, assigned to The Texas company) anhydrous calcium base lubricating greases are stabilized as to structure

if one-half to three percent estolide of a C₁₂ to C₂₄ hydroxy fatty acid is present and the final mixture is shock chilled. This shock chilling consists of cooling from about 190 to about 100°F. at the average rate of 2° per minute.

To illustrate both the composition and the processing three examples are given. In the first case an attempt was made to prepare an anhydrous calcium stearate lubricating grease without the use of a stabilizer. The attempt was unsuccessful.

Next a mixture was made containing an estolide and the final mass was allowed to cool statically from 190°F. to room temperature. The mixture separated into soap and oil on standing.

Finally example 2 was duplicated except as to cooling. A reaction mixture was formed from 1430 grams of stearic acid, 131 grams of an estolide of 12-hydroxy stearic acid having an average molecular weight of 2500, 222 grams of lime,

2.5 pounds of water, and 3.5 pounds of paraffin base oil. The mass was saponified at a temperature of 180 to 200°F. for four hours and then dehydrated at a temperature of 270 to 275°F. for three hours. The remainder of the oil, 19.3 pounds and 64 grams of diphenylamine were added during stirred cooling to about 190°F. The mixture was then drawn into cooling pans having a depth of one-fourth to one-half inch where the cooling rate was more than 2° per minute. This worked into a smooth dark brown product having a worked penetration of 232.

Hydrocarbon Resistant Plug Valve Lubricant

A plug valve lubricant and sealant consists of glycerol with thickeners for the same. Sodium glyceroxide is included in the mixture in order to reduce the corrosion of metals. According to March (U. S. Patent 2,878,184, assigned to Rockwell Manufacturing Co.) the following composition is satisfactory:

Substance	Percentage range (wt.)
Glycerol	78-89
Sodium carboxymethyl-cellulose	7-3
Water soluble vegetable gum powder	2-1
Sodium stearate	2-1
Detergent wetting agent	4-2
Starch	2-1
Animal glue	3-1
Sodium glyceroxide	0.75-3.75

A typical plug valve lubricant was made in a dough mixer and contained 199.5 pounds of glycerol. One half of this glycerol was added to a cold mixer after which 15 pounds of C.M.C. was added and the mass mixed until uniform. Next the following were added in turn with thorough mixing in each instance: five pounds of Penick's powder, five pounds of sodium stearate, 7.5 pounds of Oronite wetting agent D-40, five pounds of corn starch, 7.5 pounds of granular animal glue premixed with part of the remaining glycerol, and six pounds

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Titre	40°-43°C.
Color 5¼" Lovibond Red	2-5
Color 5¼" Lovibond Yellow	15-30
Color Gardner 1933	4 max.
Unsaponifiable	1.0% max.
Saponification Value	200-205
Acid Value	199-204
F.F.A. as Oleic Acid	100.0% min.
Iodine Value (WIJS)	55 max.

COMPOSITION

Myristic	3%
Palmitic	29%
Stearic	15%
Oleic	47%
Linoleic	5.5%
Linolenic	0.5%

FATTY ACIDS by A. GROSS provide

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of Brazil Rio de Janeiro, Brazil



**LUBRICANTS • WAXES
PROCESS PRODUCTS**

of sodium glyceroxide. After the mass is uniform the remainder of the glycerol is added and the mixture is heated to 260°F. until uniform. Finally the product is cooled to 90 to 100°F. before it is packaged or extruded in the form of sticks.

Grease Composition Containing Sodium and/or Lithium Soaps of Low, Intermediate and High Molecular Weight Acids, Together with Glycerol.

Lubricating greases which retain their original character over a wide range of operating conditions and are stable in the presence of water consist of lubricating oil thickened with balanced proportions of soaps of low, intermediate and high molecular weight fatty acids. When such soaps are those of sodium or lithium, 1 to 5 percent of glycerol or diethylene glycol must also be present in the composition.

Such products are described by Liddy (U.S. Patent 2,878,186, assigned to Socony Mobil Oil company) who states that ten to 50 weight percent of the total acids shall be those having one to six carbon atoms per molecule, 30 to 70 weight percent those having seven to twelve carbon atoms per molecule and ten to 50 percent those having thirteen to 22 or more carbon atoms per molecule.

Typical components and characteristics of the finished lubricating greases are shown in Table I:

Table I

Experiment No.	1	2
Caprylic Acid	5.82%	—
Capric Acid	—	8.7%
Stearic Acid	3.42%	5.4%
Acetic Acid	6.00%	1.6%
Lithium Hydroxide Monohydrate	—	4.2%
Sodium Hydroxide	6.85%	—
Glycerol	5.14%	2.2%
100 Second Paraffin Oil	72.77%	77.9%
Unworked Penetration at 77°F.	405	358
Worked Penetration at 77°F.	409	339
Dropping Point °F.	461	455

Grease 1 was made by charging all

Table II

Composition	1	2	3
Capric Acid	12.4%	—	—
Caprylic Acid	—	16.0%	9.14%
Acetic Acid	2.2%	10.5%	6.03%
Glycerol	3.3%	4.3%	4.89%
Lithium Hydroxide Monohydrate	4.7%	12.0%	—
Sodium Hydroxide	—	—	6.52%
Naphthenic Oil—750 sec. @ 100	77.4%	57.2%	73.42%
Dropping Point °F.	494	420	378
Penetration			
Unworked at 77°F.	368	—	365
Worked at 77°F.	349	—	360
Description of Product	Plastic	Semi-Fluid	Plastic

of the acids, a saturated aqueous solution of the alkali and half of the mineral oil to a grease kettle. The mass was heated to about 350°F. at which temperature it was held for one-half hour to dehydrate. After heating was discontinued, the remainder of the oil was added and the product paddled and cooled to 140 to 150°F. The lithium base lubricating grease can be made in a similar manner.

In U. S. Patent 2,878,187, Liddy

describes similar lubricating greases in which the acid mixture consists of intermediate and low molecular weight acid. Typical proportions and characteristics of finished products are shown in Table II.

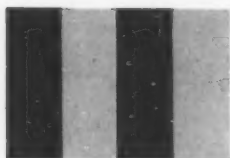
Manufacture of the lubricants was similar to that described in the previous patent except that dehydration took place at 310°F. The glycerol is charged with the other soap ingredients and the initial amount of lubricating oil.

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Industry News

Soviets Believed "Not Ahead" of U. S. in Lubricants to 1958

Soviet literature indicates that Russia and her satellites were not ahead of the United States in the field of lubricants and lubrication at the beginning of 1958, but were trying to gain headway by studying the work of others.

According to a survey of published Russian literature by a U. S. Government agency, "It appears that Soviet scientists are not ahead of any process, products, or applications." The study included ma-

terial on lubrication, lubricants and additives, and formulation of lubricating compositions.

The survey involved review of abstracts of some of the Russian technical reports appearing from 1950 to the end of 1957. It has just been released to the public as a report through the Office of Technical Services, U. S. Department of Commerce.

Red-nation researchers were apparently concentrating on areas fairly well known and defined by U. S. scientists.

This may mean, the survey concludes, that the Soviets realized the

potential importance of the field; that they were not especially proficient in it; and that the way to get established was to familiarize themselves with lubrication science and technology by checking the work of others.

Specifically, no clear-cut references were found to work being conducted on, or use of, synthetic esters as base stocks. Where lubricants were cited, it appeared that conventional petroleum products from Soviet refineries and crude sources were used. Also, no new or novel methods were being used to

Continued on page 196

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"The Case for Periodic Drain-and-Refill of Axle Differential Lubricant"

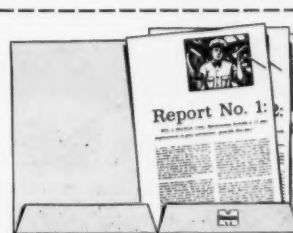
BY MONSANTO

A multimillion-dollar growth in your gear oil market can begin *this year* if all automotive manufacturers call for regular drain-and-refill of axle differential lubricant. To give policy makers in the automotive industry all the facts on the new, improved gear lubricants, Monsanto is publishing, consecutively, five reports which collectively build "The Case for Periodic Drain-and-Refill of Axle Differential Lubricant."

Now appearing in successive issues of *Automotive Industries*, this series of vital reports points out how the re-establishment of regular drain-and-refill practices—if taken across the automotive industry—will provide better differential lubrication in pas-

senger cars, trucks, buses, as well as military vehicles. It emphasizes that, today, the new, improved lubricants meet the current demands for both high-speed and high-torque axle lubrication and are nationally available through service stations.

Monsanto's multipurpose gear oil additive, SANTOPOID® 23-RI, enables lubricant makers to produce GL-4 type gear oils that meet the most stringent specifications, including good limited-slip performance. Like to see what it can do for you? Call in a Monsanto representative to arrange a qualification test in your base stocks. You'll find SANTOPOID 23-RI to be the most efficient additive for producing the new, improved gear lubricants.



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Petroleum Chemicals Department
Dept. NI, St. Louis 66, Missouri

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reports in the series,
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Serving Industry... Which Serves Mankind

Continued from page 194
provide lubrication at extremes of temperature or extremes of equipment usage.

The greatest number of references related to phosphorus chemistry, but there was no certain evidence that organo-phosphorus compounds were to be used as lubricant additives.

A large amount of research was being expended on hydrocarbon chemistry, an effort which could, the report observes, lead to new petroleum processes and products.

The volume is 59-11902 *Soviet Research in Lubricants and Lubrication*, Dec. 1958, distributed by OTS, U. S. Department of Commerce, Washington 25. It contains 27 pages, price 75 cents.

Chek-Chart Announces Publication of 1959 Truck Lubrication Guide

The 1959 edition of the Chek-

Chart *Truck Lubrication Guide* has been announced by the Chek-Chart corporation.

The guide contains 112 pages of factory-approved truck lubrication information offering coverage for the period from 1950 through 1959 on all popular standard production truck models. It also covers axle, semi-trailer and trailer units; specially assembled, heavy-duty, and special purpose trucks; and school buses and motor coaches.

The service instruction section of the guide clearly explains and illustrates the proper lubrication procedure for every item listed on the individual truck diagram charts.

The 1959 *Truck Lubrication Guide* is an essential truck maintenance tool. It lists the recommended lubricants and the service intervals; and it organizes truck lubrication service into a planned and orderly procedure which saves time and assures complete truck lubrication.

Emery Offers Bulletin

"Metholene Esters for Alkylolamides" is the title of a new technical bulletin offered by Emery Industries. The procedure is given for using methyl esters of fatty acids as intermediates to produce "super" grade amides having active amide contents of more than 90 per cent, compared to the less than 70 per cent obtained by direct amidation of free fatty acids.

Also listed are complete specifications for Emery's Metholene line of methyl esters, including methyl stearate, palmitate, myristate, laurate, caprate, and caprylate. The "superamides" prepared from these esters have excellent foam stabilizing and viscosity building properties.

For other products currently prepared directly from fatty acids, use of the Metholene esters as intermediates also offers an economical means of obtaining superior quality.

For a free copy of the booklet, write Emery Industries, Inc., Dept. 5, Carew Tower, Cincinnati 2, Ohio, and request Technical Bulletin No. 415.

Lincoln Publishes New Multi-Luber Systems Catalog

A new catalog on its line of Multi-Luber automatic power lubrication systems for trucks, trailers, material handling equipment, farm implements and industrial machinery has been published by Lincoln Engineering company, division of the McNeil Machine & Engineering company, St. Louis.

Catalog No. 50 includes illustrations and specifications pertaining to air-, vacuum- and manually-operated Multi-Luber systems, their various applications, methods of operation, and listings of component parts and accessories.

Copies are available upon request from Lincoln Engineering company, 4010 Goodfellow Blvd., St. Louis 20, Mo.

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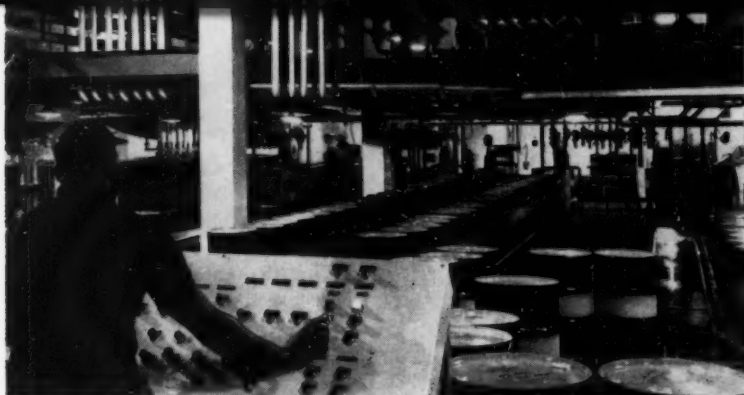
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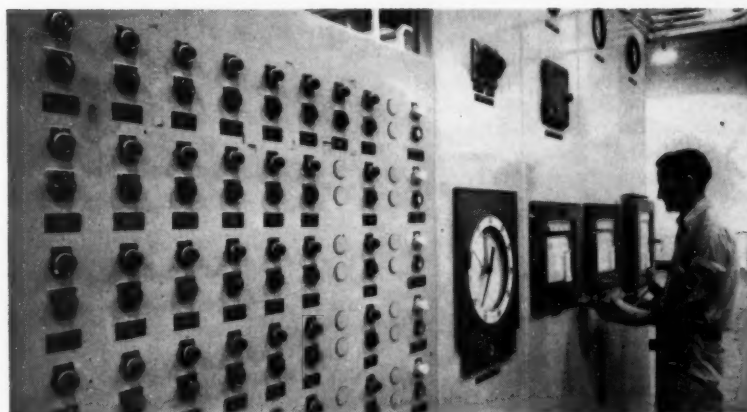
OLYMPIC 1-6600



MAZE of activity. Hundreds of oil drums travel daily from the filling machines in the background by conveyors, with a Gulf man operating the panel that controls the intricate conveyor system. The drums move forward to the end of the line where they are automatically palletized and stored in the warehouse.



MIXING kettles in the greasemaking area. Taking a sample of grease being prepared in one of the 35,000-pound capacity mixing kettles. Double motion, positive scraping agitators mix the grease to the desired consistency. The kettles extend to the floor below where the greases are pumped to both semi-automatic and fully automatic filling machines.



GREASEMAKING requires precision. G. C. Cappel takes a temperature reading from the instrument panel in the greasemaking area. On the left is a switchboard for automatically controlling the pumps in the adjacent tank fields where base stocks are stored.

Gulf Oil Co. Announces Completion of World's Largest Grease Making Plant

Gulf Oil corporation has completed the world's largest greasemaking and packaging plant at the Port Arthur, Texas, refinery.

This is a three-story building, covering more than ten acres under one roof and containing over one and one-half miles of conveyers. The entire operation of the plant is automatically and semi-automatically controlled. It is stated that approximately 800 tons of products can be packaged, stored or shipped in an eight-hour day.

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HARCHEM 2-SL



BASIS FOR THE SOLUTION TO LOW AND HIGH TEMPERATURE LUBE PROBLEMS

Harchem 2-SL is a synthetic lubricant base that meets Mil-L-7808 specifications. For the lubrication of jet aircraft, missiles and their instruments, electrical systems and servomechanisms, 2-SL assures viscosity stability through temperature ranges from -65°F to 347°F. Excellent compatibility with oxidation inhibitors, minimum corrosivity and high load carrying ability are also characteristics of this lubricant base. Requests for further information will be promptly answered.

WRITE FOR BULLETIN

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Reactive Polyepoxides

Swift & Company's technical products department, 1800-165th street, Hammond, Indiana announces the first of a new series of high purity epoxidized fatty esters. The new epoxides are produced by a new process allowing up to 96 percent conversion of unsaturated fatty esters to epoxides.

Epoxol 7-4 is the first of the series and is produced from soybean oil. It is characterized by a 7 percent oxirane oxygen and 4 epoxide groups per molecule. The new process by which it is produced minimizes the formation of hydroxylated and polymeric by-products. For this reason Epoxol 7-4 is lower in viscosity and is more compatible with non-polar resins (particularly polyvinyl chloride). The reduction of by-product formulation results in a corresponding increase in the oxirane oxygen content giving a product with higher functionality.

Epoxol 7-4 will be of interest to manufacturers of resins and coatings in which the reactivity of the epoxy groups with many types of acids can be utilized. Combinations with many types of resins are possible because of the compatibility of these epoxy fatty esters. In addition, they can be of interest as acid acceptors for use in corrosion inhibition and stabilizing plasticizers for resins.

These reactive polyepoxides differ from conventional bisphenol-epoxy resin types in functional purity, increased reactivity and lower cost. The more toxic and allergenic amine curing agents are not effective while debasic acids, anhydrides and acid catalysts can be used.

Swift & Company is one of the largest producers of fats and oils. As basic producers they plan to offer a full line of fatty epoxides in the near future although Epoxol 7-4 is the only one being marketed at the present time. Samples are available to interested people on request.

Emery Moves Office

The Chicago office of Emery Industries, Inc., has moved to new quarters at 6835 West Higgins Ave., Chicago 31, Illinois. The new telephone number is Rodney 3-5747.

Because of its proximity to the new toll roads and expressways surrounding the city, the new location provides easier access to the entire Chicago area. Emery's present warehousing operation in Chicago will continue unchanged.

Rieke Designs Explosion Proof Drum Plug

Rieke Metal Products corporation has designed and produced an explosion proof drum plug, a drum fitting that vents volatile gases and prevents drums from exploding and scattering the flammable contents.

The plug is designed to act as a relief valve when internal pressures of thirteen to fifteen psi are developed. In the opinion of Raymond F. Ouer, general sales manager for Rieke, the new plug, with its safety feature, has a definite place in the packaging of highly volatile products.

A free sample is available upon request by writing the main office at Auburn, Indiana.

Clarification of Witco Grease Royalties

Referring to a story on a new grease in July's NLGI SPOKESMAN, Witco Chemical has advised NLGI of the following: "Manufacturers purchasing the soap made with sebacic acid as one of the components from Witco or its licensees, according to Patent 2,699,428 may market the grease produced therefrom without the payment of royalties."

Foote Mineral Company Form New Development Group

W. Frederick Luckenbach, Jr., has been named general manager of Foote Mineral company's newly created commercial development department, it was announced by

Director of Marketing James Fentress. The department will be responsible for the introduction of new products and for the adaptation of existing products to new uses.

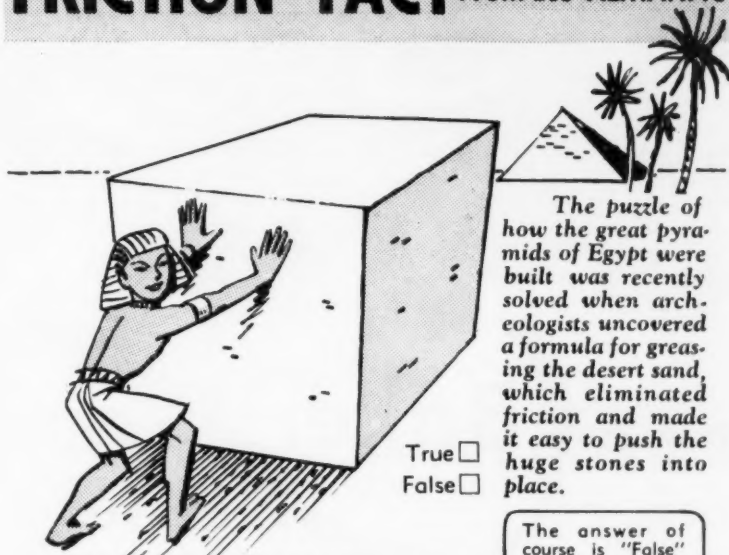
Winslow W. Bennett, Daniel Devlin, Robert J. Longenecker and Joseph B. Milgram, Jr.,—all presently members of Foote Mineral's sales department—have been assigned to the new department.

Luckenbach had been manager of

chemical sales since 1954 and has served in both sales and research during his ten years with Foote. He is a graduate of Rutgers university and a former research director for the company.

He is a member of the American Chemical society, The American Rocket Society, The American Society of Lubrication Engineers and is Company Representative to the National Lubricating Grease Institute.

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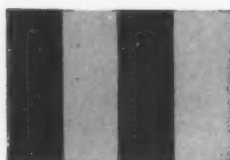
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People in the Industry

Southwest Grease Names New Officers

Recently, it was announced by the board of directors of Southwest Grease & Oil Co., Inc., of Wichita, Kansas, the appointment of two new company officers and the election of a new board member.

Quentin L. McCabe, who just joined Southwest Grease, was appointed comptroller-treasurer and director. Mr. McCabe comes to Southwest from Battenfeld Grease and Oil company of Kansas City, Missouri, where he served as treasurer-director. He is a CPA with a wealth of experience in the lubrication industry.

The appointment of Walter L. Pannell as vice president of manu-

facturing was also announced. Mr. Pannell is a Southwest veteran, joining the firm in 1949 as a grease-maker. Walt came to Southwest Grease from his native Canada, where he had been in the lubrication manufacturing business for many years.

H. F. Dearmore, a local Wichita oilman, was elected to serve on the Southwest board of directors. Mr. Dearmore has been associated with the oil industry for many years as retailer and producer.

Mr. H. A. Mayor, Jr., executive vice president of Southwest Grease, emphasized that business during the first eight months of the 1959 fiscal year has been the best in the company's 26-year history. He stated

that sales were up some 25 per cent over last year. He mentioned that the many new products and programs being offered to Southwest customers were being received with a great deal of enthusiasm. These programs included:

1. The new revolutionary Bracon tube program for lubricating greases, oils, and waterless handcleaner.
2. A brand new heavy-duty brake fluid program.
3. An ATF program.
4. A new metallic tube container for lube products.
5. A multi-duty cleaning compound.

Mr. Mayor also pointed out that many new expansion programs are

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TRADE NAME	BAKER'S CASTORWAX® HYDROGENATED CASTOR OIL	BAKER'S HYDROXYSTEARIC ACID	BAKER'S METHYL HYDROXYSTEARATE
Melting Point	86°C (187°F)	69°C (156°F)	50°C (122°F)
Acid Value	2.	178.	4.
Saponification Value	180.	188.	180.
Hydroxyl Value	160.	154.	171.
Heat Stability Loss of Acid Value (6 hrs. at 285°F)	NONE	24%	NONE
Loss of Hydroxyl Value (6 hrs. at 285°F)	NEGLIGIBLE	27%	NEGLIGIBLE

Samples and technical data on request.



THE

CASTOR OIL COMPANY

BAYONNE, N. J.

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NLGI SPOKESMAN

being undertaken at Southwest in order to furnish their customers with the best and fastest service. There have been new kettles added to the now existing production line in addition to new receiving and storage tanks. Several unique automatic filling machines have recently been installed in order to step up production to meet customers' orders. Many new streamlined production techniques have been introduced in order to give better customer service.

Mr. Mayor predicted that business would remain good for the balance of the year, with continued emphasis being made on the "Sell Like '60 in '59" promotional program.

Bennett Industries Elects Officers

1959 marks the 50th year of the Bennett name in the steel industry. Bennett Industries, Inc., of Peotone, Illinois, manufactures steel pails and drums, fibre drums, and fabricate structural steel and plate.

Mr. S. A. Bennett, president, has announced the election of additional company officers as follows:

Mr. A. J. Gasbarra, executive vice president, has been elected a director. Mr. L. A. Istel has been elected vice president and assistant general manager; Mr. W. R. Chapman, vice president and general manager of structural division; Mr. J. B. Drevier, assistant secretary, controller and assistant to the president; Mr. R. R. Ernst, vice president and sales manager of container division; Mr. W. R. Parsons, assistant secretary, sales manager and chief engineer of structural division; Mr. H. F. LePan was re-elected vice president, director of sales, container division, and Mr. K. F. Hauert was re-elected vice president.

All these men have been with Bennett enterprises in various capacities for many years.

Mitchell Named to Foote Research Post

David W. Mitchell has been named as coordinator, research and production, by Dr. E. M. Kipp, di-

rector of research, Foote Mineral company. In addition to his new assignment, Dr. Mitchell will continue to act as manager of minerals research. He will be located at the company's research and development laboratories in Berwyn, Pa.

Since joining Foote in January,

1957, he has been engaged in mineral beneficiation research at the company's lithium mine, King's Mountain, N. C.

He is the author of many technical papers dealing with metallurgy, chemistry and ceramics and is an

Continued on page 204

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prompt shipment

all styles ...and sizes 1 to 55 gallons

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Vulcan's stock of full open head and tight head pails assures prompt shipment of all popular styles and sizes! Huge warehousing facilities enables Vulcan to fill your pail needs fast . . . whether you order a carton, a truckload, or carloads. Vulcan also specializes in fast shipment of 15, 120 lb., 30, 55 gallon and larger steel drums in both open and tight head styles with a variety of fittings and accessories. Hi-Bake linings for the protection of a wide variety of products are available on both pails and drums, or if none is presently available, Vulcan will work with you in developing a new lining. Vulcan also manufactures 55 gallon Agitator Drums.

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Representative—S. A. Bennett

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Representative—Henry Frazin

Cleveland Container Company

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Representative—R. D. Sayles

Continental Can Company, Inc.

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Representative—F. J. Blume

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Division, United States Steel Corporation
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Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill.
Representative—Mrs. G. A. Krawetz

Continued from page 201

active member of the American Institute of Mining and Metallurgical Engineers, the American Chemical Society, and the American Society for Metals.

Dr. Mitchell received his PhD degree from the University of California in 1947, and taught in its department of Metallurgy for twelve years.

Emery Appoints Williams

George R. Williams has been appointed to the development and service department of Emery Industries, Inc., Cincinnati, Ohio. He will be succeeded in Emery's New York organic chemical sales office by Robert H. Endres, who has been serving the Pittsburgh territory.

Under the supervision of J. D. Farr, acting director of development and service, Williams will be concerned with the development of

markets for Emery's expanding line of fatty acids and organic chemical derivatives. Among his initial assignments will be the coordination of all phases of the company's extensive program on the utilization of dimer acid in the production of orethane foam.

Since joining Emery's organic chemical sales department in 1956, Williams has served as sales representative in the greater New York City area. He holds bachelor's degrees from the University of Chicago and the University of Wisconsin and is a member of the Salesmen's Association of the American Chemical Industry, the Society of Plastics Engineers, the Montclair Society of Engineers, and Alpha Chi Sigma.

Robert H. Endres, who joined Emery two years ago, will now have his headquarters at Emery's New York office. He will work under the direction of J. P. Clancy, eastern district sales manager, handling the sale of Emery's organic chemical line, including azelaic acid, dimer acid, plasticizers, fatty esters, lubricant esters, and pelargonic and other low molecular weight fatty acids. He is a graduate of the department of chemical engineering of the University of Colorado.

Dr. M. Z. Fainman Is Made Director of Research

The appointment of Dr. Morton Z. Fainman as director of research for Bray Oil company has been announced by Dr. Ulric Bray, president.

Dr. Fainman, formerly executive engineer with Inland Testing laboratories and senior project chemist for Standard Oil company of Indiana, is nationally known for his application of the principles of physical-organic chemistry to the synthesis of lubricant esters and hydrocarbons.

At Inland Testing laboratories, he was manager of the chemical and petroleum laboratory and responsible for planning and staffing the facility. He also supervised research, development and testing in

diverse fields including the evaluation of fuels, lubricants and hydraulic fluids in a radiation environment.

Dr. Fainman received his PhD in Organic Chemistry from the University of Chicago and has many patents to his credit as well as papers published in leading engineering and chemical journals. He is a member of American Chemical Society, American Association for Advancement of Science, American Society of Lubrication Engineers, American Society of Mechanical Engineers and Sigma Xi.

H. C. Meyer, Jr., to Head New Department at Foote Mineral

H. C. Meyer, Jr., has been named general manager, market research and control, it was announced by James Fentress, director of marketing, Foote Mineral company. Meyer's new position, recently created as a part of a general reorganization of Foote's sales department, also includes liaison with the company's research and development department.

Meyer has been with Foote Mineral since 1940, serving in both research and sales. He was most recently manager of market development. He is a member of the American Chemical Society, Chemical Market Research association, Commercial Chemical Development association and the American Association for the Advancement of Science.

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Lithium hydride is one of the most versatile metal hydrides available to the chemist. Long known for its unique solubility properties as compared with other alkali metal hydrides, this lithium compound has amassed an impressive number of applications—both present and future—that go far beyond original expectations. A few examples are in order:

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Lithium hydride can convert carbon dioxide to free carbon... can reduce acetyl chloride to acetaldehyde and lithium chloride (illustrated above)... can be used to prepare new hydrides which would otherwise be unobtainable except in small yields and by difficult synthesis... functions efficiently in many organic condensation and reduction reactions... and can easily be increased in solubility or controlled in reactivity by conversion to mixed hydrides.

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Lithium hydride reacts with alcohols to form lithium alcoholates and hydrogen. This reaction makes possible

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Lithium hydride is an ideal source of hydrogen... just one pound of lithium hydride will generate as much as 45 cubic feet of hydrogen gas at S.T.P. This gives you more hydrogen per unit of weight than can be secured by using "bottled" gas in steel containers.

... as a nuclear shielding material

N_H of lithium hydride is 5.90 compared to 6.68 for water at room temperature. And because of its low dissociation pressure at its melting point (27 mm at 680°C.), lithium hydride can be heated to red heat in a thin-wall container... without requiring a pressure shell. It appears to be stable indefinitely at this temperature.

These and many other useful characteristics of lithium hydride may help improve your product or process. For complete technical data, write for Bulletin 102. Address request to Technical Literature Dept., Foote Mineral Co., 402 Eighteen West Cheltenham Bldg., Phila., 44, Pa.



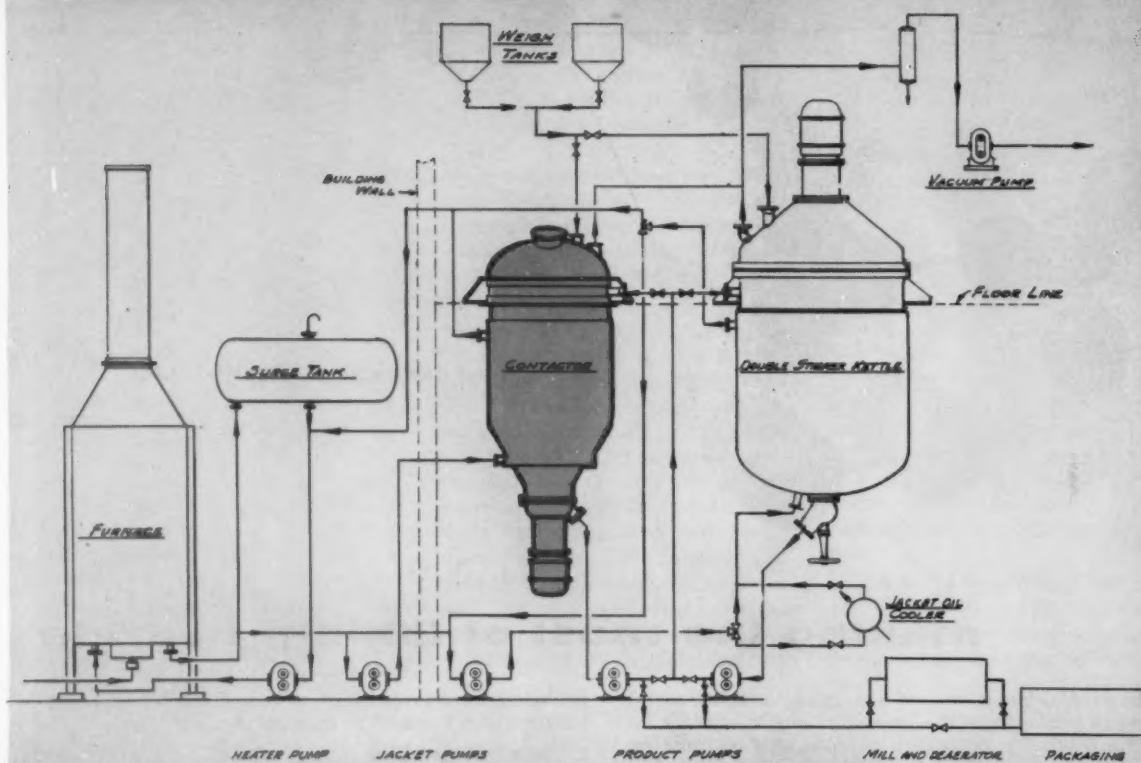
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Compared with other systems, Stratco

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A complete Stratco plant layout is illustrated above. Equipment is adaptable to modernization programs as well as new installations. Specific equipment recommendations made without obligation.

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